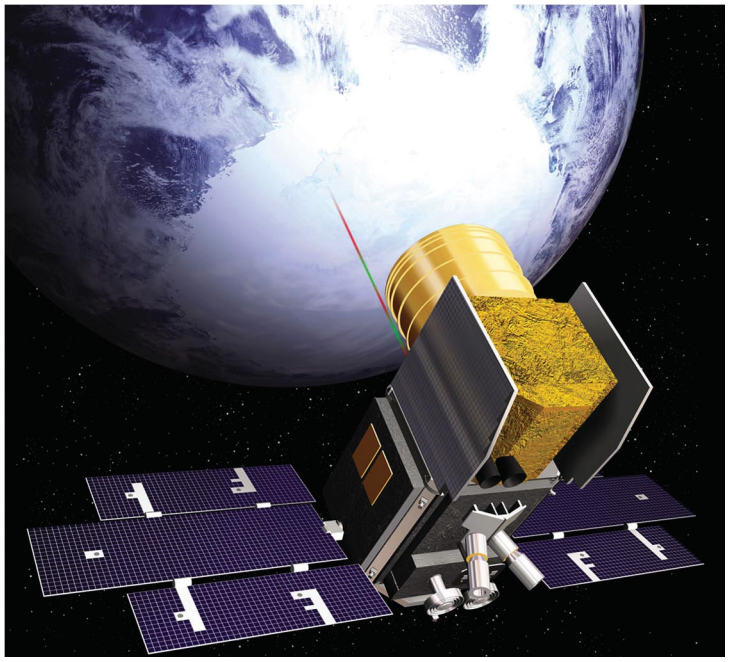
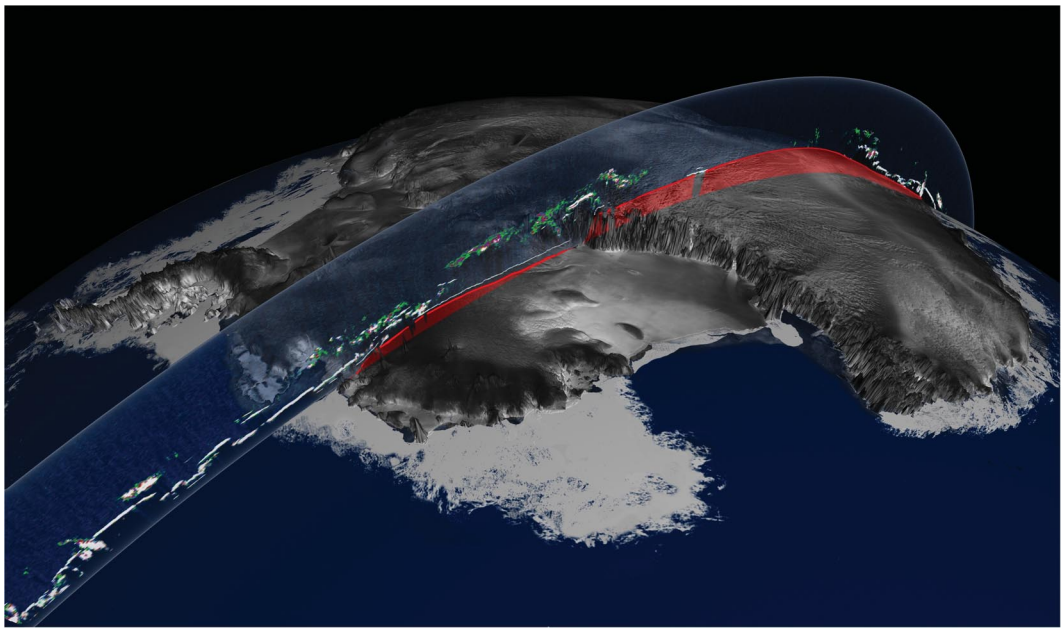
The Laboratory for Terrestrial Physics

2003 Annual Report



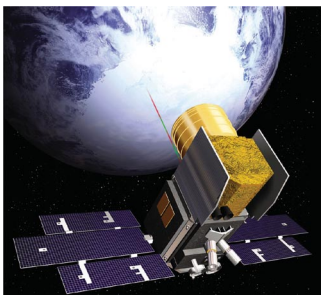
Focusing on the Lab's Laser Remote Sensing Program!



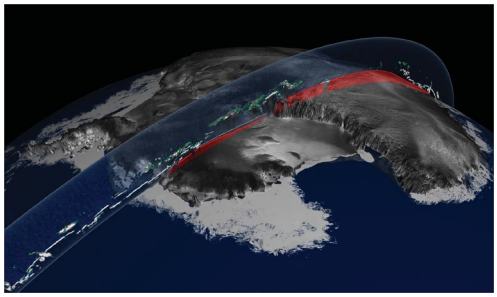
NASA Goddard Space Flight Center
Greenbelt, MD 20771

Laboratory for Terrestrial Physics
NASA Goddard Space Flight Center

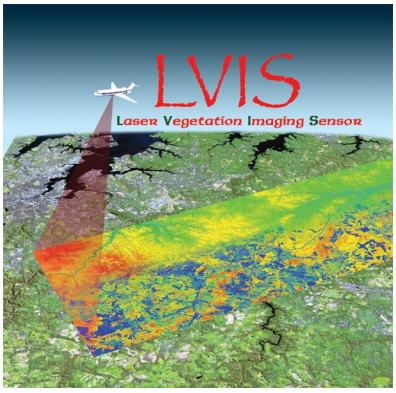
The cover of the Laboratory for Terrestrial Physics 2003 Annual Report showcases our laser instrumentation program.



Front Cover - The Geoscience Laser Altimeter System: GLAS is the first space lidar in a polar orbit around Earth, and is the primary scientific instrument on ICESat. It combines a high precision surface lidar with a sensitive dual wavelength cloud and aerosol lidar. GLAS has three lasers that emit laser pulses at 1064 and 532 nm wavelengths. The lasers operate at eye-safe signal levels and only one operates at any given time. GLAS operates continuously on-orbit and emits laser pulses at a rate of 40 Hz from the Earth-facing side of ICESat. GLAS precisely measures the time it takes for the laser pulse to pass through the atmosphere to the Earth, reflect, and travel back to GLAS. The distance from ICESat to the laser footprint on Earth can be calculated by applying corrections for the speed of light through the atmosphere and for the motion of the satellite. ICESat accurately calculates its position in space by using on-board GPS (Global Positioning System) receivers, augmented by a network of ground GPS receivers and satellite laser ranging stations. The angle of the laser beam relative to stars is measured precisely by GLAS with star-tracking cameras on the zenith side of ICESat. The data on the distance to the laser footprint on the surface, the position of the satellite in space, and the pointing of the laser beam are all combined to calculate the elevation and position of each point measurement on the Earth's surface. The Laboratory led the GLAS instrument definition and led the development and testing of many of its measurement-related subsystems and algorithms.



Front Cover - Sample Ice sheet elevation and cloud profiles from GLAS: This figure illustrates ice sheet elevation and cloud profiles from GLAS on its first day of operation. On February 20, 2003 GLAS collected a 1064 nm wavelength profile across Antarctica: the lower West Antarctic Ice Sheet in the foreground is separated from the higher East Antarctic Ice Sheet in the background by the steep TransAntarctic Mountains. The elevation profile (in red) is depicted relative to the Earth's standard ellipsoid, with 50x vertical exaggeration. Data collected across floating sea ice and open water of the adjacent Southern Ocean cannot be shown at this scale. Clouds of various thicknesses are indicated by colors changing progressively from light blue (thin clouds) to white (opaque layers). Note that the laser cannot penetrate the thickest clouds causing gaps in the elevation profile below. Data from RADARSAT is used to render the surface of the Antarctic continent. The Laboratory has key roles in GLAS and ICESat science data analysis,calibration and validation.



Back cover - LVIS: This graphic shows a wide swath of data collected using the Laser Vegetation Imaging Sensor (LVIS). LVIS is a medium-high altitude airborne, wide-swath laser altimeter (lidar) system that digitally records the shape of the returning laser pulse (i.e. waveform) of every laser shot. Shown in the background is a Landsat 7 image for the corresponding area. LVIS was developed at and is operated by NASA's Goddard Space Flight Center. The area of the LVIS data in this image is ~18 x 60 km in size and reveals the ground topography, including sub-canopy (shown in the nearfield of the graphic), and vertical extent of vegetation and manmade structures in this region of the Patuxent River Watershed in Maryland. The data were collected between August 14th and 16th 2003 as a part of a collaborative project between NASA/GSFC, the University of Maryland, and George Mason University. These data are geolocated by combining the measurement of the roundtrip travel time of each laser pulse with the pointing information and GPS-derived location of the sensor at the time of each laser shot. Data products derived from the laser waveforms allow unique information on both land surface topography and vegetation vertical structure (from which we can derive estimates of above ground biomass) to be collected for every pixel. Pixel size in this image is 12m. Graphic credit: Phillip Padden

Contained In This Report...

Editorial oversight was provided by Darrel L Williams, Associate Lab Chief for Science. He can be contacted at Darrel.L.Williams@nasa.gov

You can view an electronic version of this report in .pdf format on our website: http://ltpwww.gsfc.nasa.gov

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Introduction

Thank you for taking the time to acquaint yourself with the Laboratory for Terrestrial Physics and our accomplishments for 2003!

The Laboratory advances NASA programs through the exploration of Earth and planetary solid-body physics. These explorations involve the physics and dynamics of the Earth, as well as of the planets and their satellites. The Lab's innovative and exciting programs study the global properties of the solid Earth, global and regional scale vegetation monitoring, biosphere-atmosphere interactions, and laser remote sensing. The New Space Exploration Initiative is expected to offer exciting additional opportunities in science and instrumentation for both the Moon and eventually Mars.

The Laboratory's laser measurement research studies new techniques based on analysis and tests with airborne and spaceborne instruments. Accordingly, this area links the scientific requirements to define, design, build, and demonstrate instruments for Earth and planetary remote-sensing science programs. The laser research itself is focused on improving the understanding of electro-optical sensor physics, and the propagation environment. Additional technological skills are employed in the development of advance techniques for defining subsystem performance through the development and engineering of flight instruments, and the calibration and characterization of these instruments in realistic environments.

The Laboratory's "geophysical and geodynamic" studies span a wide range of subjects in the research of both the Earth and solid planetary bodies, especially Mars. Present-day measurements using both surface and satellite data, models derived from these, and other observational and theoretical information, are used to help improve our understanding of the evolution of the core, mantle and crust, and their interactions with surface topography.

The Laboratory's Biospheric Sciences program encompasses a broad range of basic and applied research to study terrestrial ecosystems and their interactions with the atmosphere using multi-scale remote sensing, modeling, and advanced analytical techniques. Experiments and investigations utilizing new techniques and capabilities enhance our understanding of global processes for Earth System Science.

The Laboratory's information processing research focuses on developing reliable, low-cost computing systems for the production, distribution, and analysis of regional and global data sets. The Laboratory's information technology improves the security and reliability of the computing environment.

Ultimately, our activities result in the advance of scientific knowledge. To this point, the Laboratory relies on its key personnel - its scientists and researchers - to report their results in conferences, symposia, and publications. Interaction with the national and international scientific community is essential, and integrally a part of our Laboratory's efforts.

This comprehensive report includes our philosophy, an overview of our dedicated staff, and descriptions of our projects, with synopses of the Laboratory's achievements and accomplishments for 2003. This report encompasses the Laboratory's dedication to human resources, their scientific interactions, and outreach activities with the outside community.

Please take some time to peruse this report, and contact me or my staff if you have any questions, concerns, or comments.

Sincerely,

David E. Smith
Chief, Laboratory for Terrestrial Physics

Our Mission and Place within NASA

Mission: The Laboratory for Terrestrial Physics is dedicated to the advancement of knowledge in Earth and planetary science, by conducting innovative research using space technology.

The Laboratory's mission and activities support the work and new initiatives at NASA's Goddard Space Flight Center (GSFC). The Laboratory's success contributes to the Earth Science Directorate as a national resource for studies of Earth from Space. The Laboratory is part of the Earth Science Directorate based at the GSFC in Greenbelt, MD. The Directorate itself is comprised of the Global Change Data Center (GCDC), the Space Data and Computing Division (SDCD), and four science Laboratories, including Laboratory for Terrestrial Physics, Laboratory for Atmospheres, and Laboratory for Hydrospheric Processes all in Greenbelt, MD. The fourth research organization, Goddard Institute for Space Studies (GISS), is in New York, NY.

Relevant to NASA's Strategic Plan, the Laboratory ensures that all work undertaken and completed is within the vision of GSFC. The philosophy of the Laboratory is to balance the completion of near term goals, while building on the Laboratory's achievements as a foundation for the scientific challenges in the future.

For your convenience, we have published this report on the Internet on our website:

http://ltpwww.gsfc.nasa.gov/

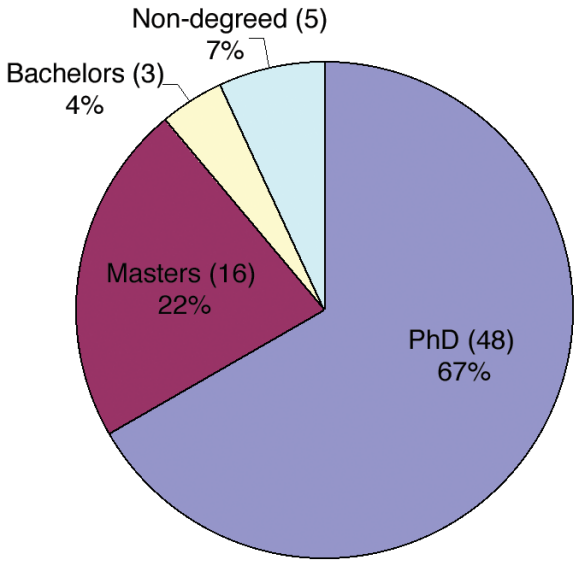
Organizational Structure

The Laboratory for Terrestrial Physics is one of 4 scientific institutions within the Earth Sciences Directorate, sharing research with the Laboratory for Hydrospheric Processes and Laboratory for Atmospheres, and the Goddard Institute for Space Studies.

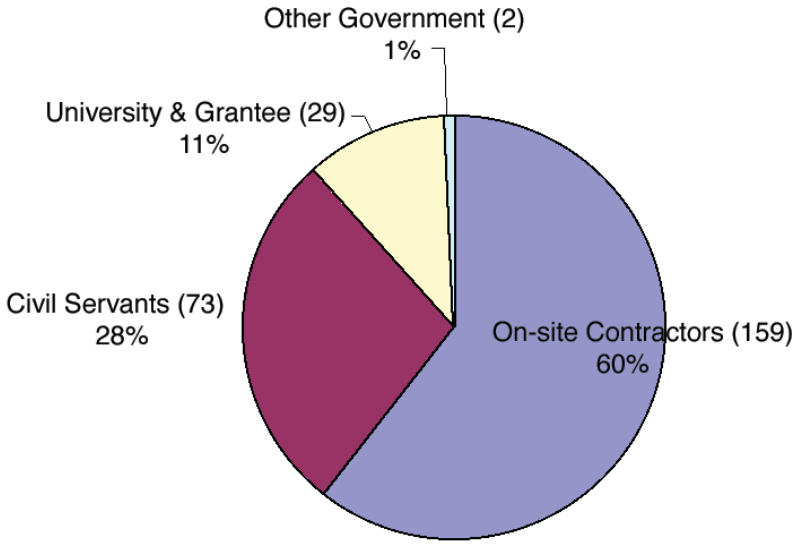
Staff

The Laboratory hosts 73 civil servants (70 full-time permanent), and 159 on-site supporting contractors. University grants and cooperative agreements draw 29 additional scientists and technologists. There are 2 additional employees from other government agencies who are long-term residents within the Laboratory. The average age of a Laboratory civil servant is 51, and the average age of all professionals is 53. Ages range from 21 (secretary) or 34 (researcher) to 78. For the civil servants within the

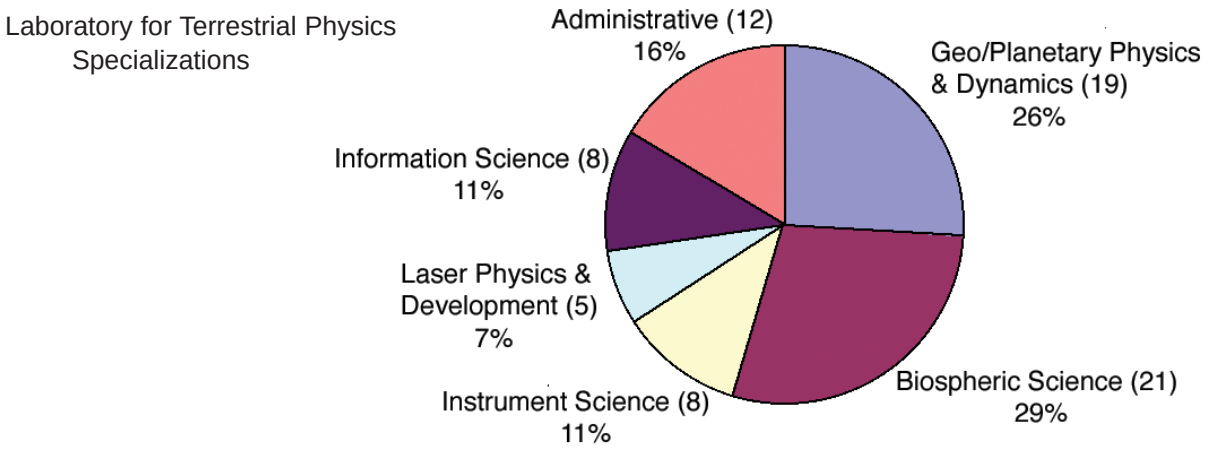
Laboratory for Terrestrial Physics
Civil Servant Degree Level



Laboratory for Terrestrial Physics
Total Population



Laboratory, the average length of government service is over 20 years; a majority of those have spent their entire time within the Laboratory. This may be taken as an indicator that the Laboratory is a "good place to work."



There are many different professional skills represented within the Laboratory. As a gross summary, there are 19 researchers in geo/planetary physics and dynamics; 21 in biospheric sciences; 5 in laser physics and development; and 8 each in instrument science and information science. Additionally, there are 12 employees who devote the majority of their time to administrative tasks, from project science to office administration.

The Laboratory is composed of 5 branches, 2 offices, 4 staff scientists, and a large number of cooperating institutions. Particularly notable in the latter category are MIT, University of Maryland at College Park, University of Maryland Baltimore Campus; Scripps Institute of Oceanography (one Laboratory employee is permanently located there), the U.S. Geological Survey, and International Laser Ranging and Very Long Baseline Interferometer services. Branches range in size from 7 to 20 employees; offices from 3 to 5.